The Influence of Analytical Pre-Study in Memorizing Piano Music

BY
GRACE RUBIN-RABSON, PH.D.

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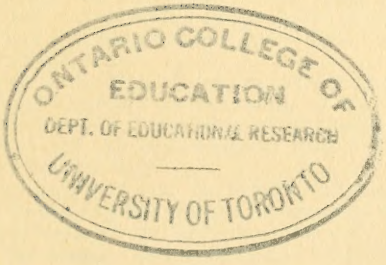

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G. R.–R.

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INTRODUCTION

In the middle of the 19th century, Franz Liszt, composer and sensational pianist, created a new vogue, when in a moment of interpretive fervor, he cast the music score from the rack and continued his recital from memory. This startling innovation has long since become traditional in solo recital and threatens soon to include chamber music and orchestral conducting as well.

The advantage of memorized performance of ensemble music is problematical, but is obvious for solo presentation. Not only the dependence of the artist on his notes, but the very physical presence of the music score destroys the illusion of spontaneous creation.

The necessity of memorizing repertory material has proved a serious obstacle even to gifted music students. The most talented pursue a course of their own, achieving success by methods which they themselves are unable to analyze. The less gifted, with no procedure to guide them, either give up memorizing altogether or by dint of the most exhaustive labor produce a result whose undependability makes public performance a source of the greatest apprehension. This is especially true on keyboard instruments where either hand has a similar function. Under such circumstances, it is, of course, difficult to achieve beautiful interpretation.

Since the number of music students is constantly increasing, it is apparent that specific aid is needed in the memorization of piano music. Though some individual teachers of piano have undoubtedly been effective in solving this problem for their own students, no fundamental principles have been established under laboratory conditions.

The present study was undertaken as a first step toward the solution of the problem with the hope that valid conclusions concerning the particular aspect presented here would form a basis for further experimentation.

CHAPTER I

PREVIOUS RESEARCH IN THE PSYCHOLOGY OF MUSIC

In view of the hundreds of researches which exist in the psychology of learning, it seems incredible that the important area of music learning has been so largely neglected. Musicians and music teachers have written prolifically from their studio experience, but their comments and advice not only derive from no scientific basis but are profoundly conflicting as well. Ruckmick (34) sums up many of these published observations to indicate the utter lack of unanimity that exists among them concerning learning, memorizing, sight reading, practising habits, etc.

Though lacking in scientific validity, much "practical psychology" has been incorporated in the working and learning procedures of successful musicians. Edwin Hughes (17), a well-known pianist, says of memorizing:

> Retentiveness depends largely on the strength of the impressions made during the first attempts to master a new composition. . . . The moment the pianist plays for other listeners than himself, conscious thought is brought to a sharp focus not felt at all when playing alone.

Cooke (9), in a series of educational conferences with well-known musicians, reports individual working habits in memorizing: Ernest Schelling advocates memorizing by sight, by ear, and by finger. Fanny Bloomfield Zeisler suggests several repetitions with the music before memorizing, and concentrating on difficult passages. Ethel Leginska memorizes phrase by phrase at the piano, resorting to silent score reading only when an instrument is unavailable.

Chase (8), in her book "Natural Laws in Piano Technic," incorporates what proves to have psychological validity in this observation on memorizing:

> The greatest aid to concentration and the basic principle of all memorizing is the analysis and mental grouping of all sequences of fundamental and harmonic progressions, rhythm and fingerings. This should be done from the beginning of practise and much time and strength will be saved if done at first without the piano, phrase by phrase, then at the piano.

Comparing many of these practical judgments with the results of experimental studies done in non-musical areas, Salter (35) concludes that on the whole the present methods in piano memorizing

agree fairly well with the inferences drawn from experiments in memorizing in other fields. Nonetheless, he urges the need for definite experimentation in the field of music itself, as well as general agreement on the results of the experimentation. In view of the fact that many of the conclusions of the studies mentioned by Salter conflict among themselves, it would be expected that support could be found for most of the conflicting practical judgments.

The number of experimental studies in the psychology of music learning is incredibly small. Mursell ('32) (28), in a bibliography of 258 titles, lists only seven. Gordon (13), comparing the learning of musical themes with the learning of series of nonsense syllables, found that the musical selections were easier to learn than the nonsense syllables, but that the difference between the two as indicated by ease of memorizing is less marked than the usual difference between significant material and nonsense material. Juhasz (18) studied the circumstances of musical recognition using series of three tones which he considered analogous to nonsense syllables. Heinlein (15) found melodic configuration of great importance in the musical memory span. Koenig (21) found a decided superiority in memory span for tones in musicians over non-musicians. Smith (38) formulates some of the psychological conditions of "ear-training." Only two studies of the seven deal with the learning or memorizing of piano music.

Brown ('28) (5) attempted to discover the relative advantages of "whole" and "part" learning of piano material. In the "whole" method, no corrections of any kind were allowed. In the part method, individual sections of the composition were practised until perfected. A third or "combination" method was introduced which emphasized the "whole" approach but allowed the subject to correct errors. The material used for the various methods was unequal in difficulty. Since the experimental procedure did not rotate the compositions and the methods, it was impossible to arrive at some one score which would indicate definite superiority of one method over the other. Her conclusion is that the efficiency of the method is a function of the nature of the composition itself.

The other one, a study by Kovacs ('16) (22), since it is specifically concerned with the same problem investigated by the writer, is more fully discussed on page 9.

Eberly ('21) (10) antedated Brown's study in "whole" and "part" learning. Five subjects learned several classic, romantic and modern compositions by both methods. In spite of prejudice

on the part of the subjects in favor of the "part" method, an economy of 27–87 percent in learning time was found to the advantage of the "whole" method. The experimental material, however, was only nineteen measures in length so that the successful application of this result to longer piano material is problematical. Further, the subjects learned the material to the point of fluency before memorizing it, making the learning and memorizing two distinct functions.

Two later studies by Brown ('33) (6) continue her investigations in the essentials of learning piano music. In the first (15) she observed the relative merits of practising piano material with hands separated and with hands together. She concluded that practising with both hands together is more efficient and more enjoyable than working with either hand alone. In the second ('34) (7) she investigated the advantages of learning to play by touch with the fingers covered. The work was done with very young children and the results are inconclusive.

Mainwaring (26) in the foreword to a study dealing primarily with the study of memorizing vocal music, maintains (without experimental proof) "that memorizing on a keyboard instrument is almost wholly kinaesthetic." That the finished public performance is largely kinaesthetic seems indubitable. Nevertheless, the learning-memorizing process may rely on other factors.

Kovacs' study (22) is the only one which deals with the aspect of memorizing reported in the present study. A very active teacher of piano in Budapest, he says, apropos of the need for research in this area:

> Prodigious amounts of time and energy are wasted in attempting to memorize. It is of the utmost importance that we find useful procedures. Even the musically talented can not learn successfully from memory in spite of the most energetic work. An enormous number of repetitions, intense attention, even writing the composition—all are of no avail.

He names four factors entering into memorizing on a keyboard instrument: (1) The visual image of the printed score, often combined with key and hand pictures. (2) The acoustic—or auditory image which he calls "inner" hearing, or the ability to hear tones and total musical effects without external stimulus.[1] (3) The motor

[1] Betts (3) reports a high percentage of auditory imagery among music students when comparing tones with tones previously heard in a series. He observes—"that most persons can command a far wider range and greater profusion of imagery than they normally employ in thinking."

ability, (4) the secure union of the three. In analyzing his students, whom he used as subjects, he found that their difficulties were not due to the first, since they were often able to write the score from memory. They were not due to the third, since they were very advanced piano students, who were able to reproduce the most difficult technical passages flawlessly. He concludes that most of the problems arise from the failure of the second—namely, that few persons experience auditory images or hear the music with this "inner" hearing and therefore cannot guide their playing by this means. Performance becomes then not the execution of an effect already imagined and anticipated, but the execution of a well-learned series of maneuvers.[2]

This concept of auditory image or "inner" hearing may seem vague and incomprehensible. One example of "inner" hearing is the ability of an orchestral conductor to evaluate the quality of an orchestral score without having heard it performed. The story of the violin virtuoso who studied a composition on the train from New York and played it that night in Boston without having once rehearsed it on his violin illustrates this capacity. The feeling of rhythm when reading poetry or of sound on seeing onomatopoetic words are common examples from non-musical areas.

Kovacs, in a simple experiment dealing with "inner" hearing, corroborated his conclusion that few persons experience this type of imagery. Students were asked to play, in octaves, and at the slowest possible speed, the melody of an already well-learned composition. They were unable to do so. Similar failure was experienced when they were asked to sing the lower voice of an equally well-learned fugue.

Kovacs was concerned with two aspects of the problem: (1) How could a piece, already learned, but insecurely memorized be best practised—on the keyboard or in the imagination? (2) How could new material be best learned and memorized—on the keyboard or by studying the score?

He attacked the first question by requiring the student to concentrate on the score with eyes closed, making the most intense effort to see the notes in his mind's eye and to hear them mentally until the material was memorized. This was compared with memorizing by repetition on the keyboard. The results were outstandingly in favor of the "Vorstellung" or mental image procedure.

[2] Betgilel (2) says of the need for well-developed auditory images: "Je lebhafter die musikalischen Vorstellungen kultiviert werden im Geiste, umso gewisser deren glatte Realisierung."

In approaching the problem of memorizing new material, he worked intensively with five of his most gifted pupils, giving them short passages of equal difficulty, one to be learned by repetitions at the keyboard, the other by studying the score until the subject felt able to play it without errors. Some of these short passages were composed of "nonsense" material. The passages varied in technical difficulty. Again the results were decidedly in favor of the "Lese-Methode" or reading method as compared with the "Spiel-Methode" or playing method. Further, the subjects were able to reach a maximum degree of speed in shorter time with material learned by the reading method.

Two objections must be made to Kovacs' work despite the interesting results which he achieved. First, the results derived from working with fragments cannot always be applied to working with entire compositions or even to complete musical sections. Second, no provision was made in the experiment to guide the study of the score in the "Lese-Methode" or reading method so that it is impossible to know whether the subject memorized the fragment by analysis of the material or by simply staring at the notes.[3]

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[3] Henmon (16) found that with young children auditory presentation gives the more correct and lasting reproduction, and with adults visual presentation is the more effective, and proved that pure auditory presentation is the best; auditory-visual the next best; and pure visual presentations are the least efficient for retention among adults. These results were not borne out in the present study in which all the subjects were adults.

CHAPTER II

IDEOLOGY AND FORMULATION OF COMPARATIVE METHODS

Kovacs' study, vague as are its underlying hypotheses, is the only clue to the direction of further research. The present study attempts to formulate these hypotheses and to extend them by means of an approximation to a real learning situation.

Kovacs believed, as does the present writer, that the customary procedure adopted by most piano students is psychologically an unfortunate one. It is a rare student who does not immediately attempt to play new material on the keyboard. His first performance, therefore, perforce includes the reading of the musical symbols, attention to fingering, phrasing, technical difficulties, rhythm, perhaps pedalling, locating the notes on the keyboard—all of these to be coordinated at such speed and with such regularity as will give some semblance of the desired total effect.

Under such circumstances it is almost inevitable that not only will he have little appreciation of the details of the musical structure, but may even derive numerous false impressions as well. Every subsequent repetition of the material involves the same problems, diminishing in complexity as the learning is taken over by the fingers. Since this kind of learning depends almost entirely on numerous repetitions to acquire habitual motor responses before smooth performance is achieved, it might be called kinaesthetic learning.

Mainwaring (26) (without presenting his evidence) says:

> Any but the most extremely simple instrumental music can only be "memorized" by the frequent repetition of the actual production of it, *i.e.*, by the formation of a kinaesthetic habit sequence. . . . It must have involved the frequent repetitions of the whole series involved.

Nevertheless, it is possible to write the notes of a musical score verbatim from memory without having heard or played a note of it. This requires a highly developed capacity for auditory images. Further, the first keyboard rendition of a studied score may be perfect. Though such a degree of accomplishment is reserved for very few, it has been demonstrated by great virtuosi and refutes the need for these few for the "frequent repetition of the actual production of it."

The practical considerations of time spent, number of repetitions necessary for perfect performance, and the ease of upsetting the

muscle sequences, are sufficient cause for seeking improvement upon this method.

Kovacs also believed that the leisurely study of the score, freed from the necessity of producing elaborate coordinations in rhythmic sequence, produces firmer visual images on which to build the kinaesthetic learning.

The writer would extend this hypothesis by assuming that these visual images can be solidly built and retained only when they occur as the result of resynthesis after intensive analysis. Analysis replaces mere staring at the musical symbols by the formation of concepts and the eduction of relationships. The resynthesis reconstructs the visual image in terms of these concepts and relationships.

The eduction of relationships and the use of associations have been found efficacious in non-musical areas for both learning and retention.

Reed (32) points out the importance of association for retention of prose passages and finds that a prose passage arousing many associations is fifteen times better after one week and eight times better after two weeks than prose without associations. Klemm and Olsson (20) came to similar conclusions when comparing mechanical with meaningful aids and found that logical aids yielded superior retention after intervals up to 476 days. Key (19) in a study entitled "Recall as a Function of Perceived Relations," says:

> The common-place, close, and freely selected relations are the easily perceived relations.

Unfortunately, few students are as well equipped to find associations in musical material as they are to find associations in verbal material. How diligent, then, must the analysis be to discover the intricate interrelationships of melody, rhythm, and harmony!

Another unstated but implicit assumption in Kovacs' study is that the intention to memorize should exist coincident with the intention to learn. To most music students, the learning and memorizing are two separate functions, the second to be added when the first is already accomplished. The desirability of reciting (memorizing) very early in the learning is pointed out by Gates (12) who says:

> Only a very small percentage of total time required to learn should be devoted to reading. From every point of view the superiority of recitation over reading, beyond the few perusals required to furnish the initial grasp of the material is very clear. This holds for all materials and for practically all subjects.

After stating the importance in memorizing of "inner" hearing (or the ability to achieve auditory images from reading printed musical symbols), Kovacs makes no provision for insuring its operation in his comparison of the playing and the reading methods. The writer has attempted to amend this omission.

Formulation of Methods to be Compared

The purpose of the present study is to compare the efficiency of two procedures in memorizing piano music. One includes the study and analysis of the musical material before continuing the learning at the keyboard; the other omits this analytical study and confines the entire learning to the keyboard.

Since the analytical experiences of most music students are usually confined to the theory class and are rarely applied to learning piano music, it was impossible to assume that the subjects would themselves be able to demonstrate with their own analyses the efficacy of good analysis over no analysis. Therefore, two types of analytical procedure were adopted. In one of these the subject was to write his own analysis. This, whether adequate or inadequate, would offer one basis of comparison with a procedure involving no analysis at all and would in addition, offer some evidence that the time had not been spent in simply staring at the musical symbols. In the second of these procedures, the subject was to study the musical score with the aid of an analysis given him by the experimenter which would point out to him items of structure, voice movement, voice relationships, melodic construction, repetition, and the like which would be of use to him in learning and memorizing the material.

Had the subjects been sufficiently experienced in making such analysis, the assumption could be made that their own analyses would prove more helpful to them than the use of an imposed analysis. Short of an intensive training period the most practical expedient in the present situation was the use of both analytical procedures.

These two procedures were contrasted with one involving no analysis at all—namely that procedure commonly in use among music students, whereby the material is repeated over and over at the keyboard until learned.

In an effort to test the value of "inner-hearing" in aiding the memorizing a fourth procedure was adopted. A surprisingly large number of music students experience no auditory image on silently reading a music score. Others are capable of securing some feeling

of the melodic movement but nothing more. A very few achieve an approximation to the total musical effect. Since this is so, might not study of the score with no idea of the audible effect prove a purely intellectual procedure? To answer this question, a fourth learning method added the hearing of several repetitions of the musical score to each of the three learning methods described above. These four methods which were to be contrasted may be summarized as follows:

A. The subject studies the musical score with the aid of an analysis previously prepared by the experimenter, for twenty minutes before proceeding with the learning at the keyboard.

B. The subject studies the musical score and prepares his own analysis for twenty-five minutes before proceeding with the learning at the keyboard.

C. The subject proceeds immediately with the learning at the keyboard without any preliminary study period.

D. The subject listens to four repetitions of the musical score on a phonograph recording before proceeding with any one of the three methods described above.

In order to clarify the reader's understanding of the analytical methods, one of the analyses provided by the experimenter for use in the second procedure described above is appended below. The composition for which it was drawn up will be found on page 48. The other compositions and analyses used in the experiment appear in Appendices A and B.

(Abbreviations: M = Measure; L.H. = Left Hand; R.H. = Right Hand. Each measure in the score has a number below it for easy reference.)

MINUET

1. This little Minuet falls into three sections: the first—M 1–8; the second M 9–16; the third M 17–22.

2. The figure on which the composition is based is made of three quarter notes, beginning with the third quarter of the measure.

a. M 1–4 consists of 2 of these figures, each time repeated an octave higher, the second one note lower than the first.

b. The first figure—M 1–2—is built on the F-A-C chord, the L.H. forming the same chord in a broken octave.

c. The second figure—M 3–4—is built on the C-E-G-B flat chord, the L.H. forming the same chord in a broken octave.

3. M 5 the right hand is built of 3 descending triplets, the first note of each descending stepwise. The L.H. keeps the lower note constant while the upper voice descends at thirds with the R.H.

4. M 6 is built of an ascending scale to B flat in M 7.

5. M 09–10 and M 11–12 are the same, using the figure of three quarter notes in the L.H. and built on the C-E-G-B flat chord, followed by the F-A-C chord.

a. The L.H. carries its own figure alone on the C-E-G-B flat chord.

6. M 13–15 are identical with M 5–7; but M 15 is repeated by M 16.

7. M 17–18 the R.H. is built of ascending octaves.

a. In the L.H. the lower voice moves by half steps from B flat in M 17 to B natural in M 18; to c in M 19.

b. In the L.H. the upper voice moves from F to G in M 17; to A flat in M 18; to A natural and B flat in M 19.

8. The figure in M 20–21 is identical with the figure in M 9–10.

9. The composition ends on the C-E-G-B flat chord followed by the F-A-C chord.

It will be observed that no technical terms of structure or harmony have been employed, each statement being simple enough to be understood by any elementary piano student.

Though each statement is accurate, no attempt was made to produce the kind of finished theoretical analysis required in advanced analysis classes. Instead, only those points are considered which a theoretically untrained person might himself use as guidance.

No two persons, either trained or untrained theoretically, would produce identical analyses nor find the same statements equally helpful. Nor is it assumed that these analyses include every possible point or are the best that could have been produced. Some of the analyses written by the subjects contained important observations concerning the material which were either overlooked by the experimenter or not seen in the particular configuration.

For purposes of contrast and comparison two analyses of the same composition written by the subjects in the first learning procedure are appended below. Of these, the first probably proved of some value in the learning since it describes the music in musical terms, while the second, couched in the terms of popular concert program-notes, provides almost no clues as support for the learning.[1]

1. Main melodie figure—3 note going up according to chord tones 3, 5, 3, etc. (in thirds). Repeated the second time an octave higher. Modulates to subdominant (B flat) same as before. Starting on Tonic (F) Triplets going down diatonically to C then straight up to B flat (third)—little coda.
2. Second Part—Thirds in left going up to form Dominant 7th and resolve. Repeats. Same triplets as in beginning but last figure repeated instead of resolving.
3. Third Part—Octaves in R.H. L.H. B flat base with upper tone sixth below right. Then up half step L.H. notes then going in half-step. To Dominant 7th. Next like beginning of 2nd Part but in F. Ending with V7 1.

[1] Writing such analyses was a completely novel experience to every subject. For those with extensive theoretical training, analysis had been confined to the theory class. Not one had ever silently studied piano material preliminary to playing it at the keyboard.

L.H. in 1st Phrase built of Tonic & IV chord Sixth Below in Triplet section with base F.

Key of F Major. Tempo ¾.

Introductory part begins in the middle range of keyboard with a succession of thirds then one octave higher. When the invitation to the partner to dance is over, the dance proper starts with triplets in the right hand, after that a few double notes in thirds, intervals of fourth and sixth for the promenade and back to the dance in the triplets, gradually going to octaves for the promenade, finishing off with double notes for the bow and courtesy.

Double notes in middle of keyboard same one octave higher. Same one octave higher.

Back to middle of keyboard. Octave higher to C and B flat. Back to key 2 eighth notes, triplets ending on C. End comprised of octaves on minor. Starting on up beat.

CHAPTER III

METHODOLOGY

Since the experiment was designed to compare several methods of memorizing piano music, four methods were selected. They were as follows:

A. Study of the score with the aid of a given outline. Time allowed, twenty minutes.

B. Study of the score with the production of the subject's own outline. Time allowed, twenty-five minutes.

C. Learning at the keyboard with no preliminary study period.

D. A hearing of four repetitions of the composition while reading the score, preceding each of the three methods above.

To compare these four methods, four different experimental compositions were used, both methods and compositions being presented in different order to four groups of experimental subjects, each group containing an equal number of subjects. The following experimental design shows how the methods and compositions were learned in all possible combinations and in all possible orders.

Design of the Experiment in which the sequence of days represents the order of the experiment; A, B, C, and Da, Db, Dc represent the Methods used; 1, 2, 3, and 4 represent the compositions used; and Groups I, II, III, IV are the four groups of experimental subjects, comprising six subjects each.

	1st Day	*2nd Day*	*3rd Day*	*4th Day*
Group I	A–1	B–2	C–3	Da–4
Group II	Db–3	C–4	B–1	A–2
Group III	B–4	A–3	Dc–2	C–1
Group IV	C–2	*Da–1 Db–1 Dc–1	A–4	B–3

* Since method D is a combination of hearing the composition plus one of three other attacks A, B, or C, two subjects in Group IV learned Composition 1 by each one of the methods A, B, or C. Thus eight subjects in the entire experimental group used each of the combination method Da, Db, Dc.

Thus Group I learned the first composition by the A method on the first day, the second composition by the B method on the second day, the third composition by the C method on the third day, and the fourth composition by the Da method on the fourth day. (Here the D method added preliminary hearing to the study by the A method.) Group II may be similarly interpreted. Group III learned the fourth composition by the B method on the first day, the third com-

position by the A method on the second day, the second composition by the Dc method (Here the D method added preliminary hearing to study by the C method) on the third day, first composition by the C method on the fourth day. Group IV may be similarly interpreted with the exception of the learning of the first composition on the second day.

It will be observed that the first three groups each added the preliminary hearing or D, to one of the three methods, A, B, or C. The fourth group of six subjects was divided into three small groups of two subjects each of which used a different method for composition 1, after hearing the recording. The total number of subjects using the preliminary hearing with each of the methods A, B, and C was eight.

The advantages of such a rotating design are apparent. Equal numbers of subjects learn every composition by every method and in every order. It can be seen that if all the learnings by the A method are averaged and compared with all the average learnings by the B, C, and D methods, the difference in these averages will indicate the relative efficiencies of the various methods, since the influence of the other factors of individual differences, composition and order are contributing equally in all learnings and can therefore be assumed to be constant.

Since the purpose of the experiment was to allow equal allotments of time to learning of the musical compositions under methods A, B, C, and D, the efficiency of the learning methods cannot be measured by learning time, or, for that matter, by learning repetitions. The efficiency of each of the methods can best be evaluated by relearning time or relearning repetitions. The use of relearning time to measure the efficiency of a learning method is an obvious adaptation of the savings-methods used by Ebbinghaus in his memory experiments. Time required for learning is compared with the time required for relearning, the difference between the two indicating the amount of retention after a lapse of time.

In this experiment, the subjects relearned the compositions three weeks after the original learning. The same experimental design was adhered to, except that study periods were omitted and all learning was confined to the keyboard. In a sense, then, the relearning followed the C method of the original learning. If any advantage were to accrue to any method, it would be to C, since C would enjoy the advantage of maintaining the same relearning as original learning situation. It is apparent that the differences in the time re-

quired to relearn compositions originally learned by different methods will offer a clear-cut picture of the amount of retention produced by each learning method and hence its relative efficiency.

Subjects

The music schools of the Works Progress Administration were invited to send piano students willing to act as subjects in a memorizing experiment. It was hoped that persons already skilled in memorizing piano music would volunteer for the work. Of the total number who applied, however, only eighteen were used, and of this group, six maintained that they were unable to memorize at all. Six other subjects were upper classmen majoring in music at Hunter College. All the subjects were seventeen years of age or over, ranging to fifty-four years. All of them had had four years or more of formal piano training, a minimum required by the experimenter to facilitate the handling of the experimental material. All of them had had at least one term of theoretical training or its equivalent, ranging to fifteen terms. Of the twenty-four subjects there were eighteen women and six men; among them twenty white subjects and four negroes. The group comprised 3 housewives, 7 professional musicians, 9 students ambitious to become professional musicians, and 5 music students who were engaged in other pursuits for a livelihood.

Tests[1]

As a corollary to the main purpose of the experiment, it was hoped to derive further information concerning the experimental group as well as possibly significant relationships between the intellectual and musical endowments of the subjects and their actual musical achievement as measured by the length of time required to complete the musical assignments in the experiment.

What relationship exists between intelligence and the speed of learning piano material? To provide a measure of intelligence, the Otis Self-Administering Test of Mental Ability, Higher Form B, was selected because of its ease of administration, its brevity (time allowed, twenty minutes) and its high reliability.

Is memory for verbal material significantly correlated with memory for musical material? A measure of verbal memory was derived from a score of the number of ideas which the subject could remem-

[1] The tests were administered to the entire group on June 20, 1936, in the studio of the experimenter in New York City.

ber from one hearing of a prose passage. For this, the well-known story of the "Marble Statue" was used (44).

Since their inception, the value of the various tests of musical talent has been much debated. It was hoped that by selecting certain of them which had special bearing upon ease of learning piano material more light might be thrown on their validity as measured by actual musical achievement. Therefore, the Seashore Tests of Tonal Memory and Rhythm were selected, as well as five of the ten Kwalwasser-Dykema Music Tests, namely: Tonal Memory, Tonal Movement, Melodic Taste, Rhythm Imagery, Pitch Imagery.

In the Seashore Musical Talent Test of Tonal Memory, the subject is required to listen to a series which increases in length. These series are arranged in pairs. One tone changes in the second series of each pair. The subject is required to state which tone in the series has been changed. In the Seashore Musical Talent Test of Rhythm, the subject is required to state whether two rhythmic patterns are the same or different.

The Kwalwasser-Dykema Music Test of Tonal Memory is similar to the Seashore Test of the same name and provides a check on it. The Kwalwasser-Dykema Music Test of Tonal Movement presents an unfinished series of tones. The subject decides whether the tone required to complete the series should be higher or lower than the last tone heard.

The Kwalwasser-Dykema Music Test of Melodic Taste presents a short Melodic phrase with alternative endings. The subject selects the better ending. In the Kwalwasser-Dykema Music Test of Pitch Imagery, the subject is required to compare pitch intervals seen and heard. In the test of Rhythm Imagery, he is to compare rhythmic patterns seen and heard. The reliability and validity of these tests has been discussed by Mursell (29), Whitley (45), Brown (4), and other workers.

From these test scores were derived intercorrelations with learning, relearning, age, and previous musical training (Tables II, III, IV). These correlations are discussed at length in Chapter VI.

The results of these tests for the group are presented in Table I.

Table I shows the experimental group to be of extreme heterogeneity. A score of 33.5 for verbal memory is several points below Whipple's norm of 38 for males and 40 for females.

It appears, then, that the experimental group was not gifted in this respect. This below-average mental performance is not supported by the scores on the Otis. The mean here, 45.7, is

TABLE I

MEANS AND STANDARD DEVIATIONS FOR MUSICAL EXPERIENCE, FOR THE VARIOUS TESTS OF MUSICAL AND MENTAL ABILITY FOR THE ENTIRE EXPERIMENTAL GROUP

N = 24

	Mean	*S.D. of Distribution*
Age	27.4	11.40
Piano Experience (Years)	7.9	3.00
Theoretical Training (Semesters)	4.6	3.96
Otis Higher Form B	45.7	13.83
Verbal Memory	33.5	6.80
Seashore Rhythm	42.25	5.0
Seashore Tonal Memory	42.54	6.6
K–D Tonal Memory	21.65	2.6
K–D Pitch Imagery	19.1	3.0
K–D Tonal Movement	25.1	4.2
K–D Rhythm Imagery	19.9	2.8
K–D Melodic Taste	15.46	2.55

slightly above the averages given by Otis as the norm for this test which is 41 at 17 years and 42 at 18 or over. Scores made on the tests of musical ability indicate that the group appears definitely superior in the traits measured, although only a few of the tests in the two complete series were used. The means for the Seashore Tests of Rhythm and Tonal Memory correspond with the 90th and 77th percentiles respectively, in the norms for adults. In the K-D tests, the group scores correspond with adult norms as follows: Tonal Memory, 98th percentile; Pitch Imagery, 96th percentile; Tonal Movement, 94th percentile; Rhythm Imagery, 87th percentile; Melodic Taste, 85th percentile. This apparent superiority must be interpreted in the light of the fact that no member of the group had less than four years of piano experience.

COMPOSITIONS

Four compositions were used. They were complete musical forms, ranging from 16 to 26 measures in length. A real learning situation was approximated by using complete compositions instead of small fragments. This method avoids the fallacy of applying deductions derived from units to complete wholes.

The compositions used were selected by the experimenter for attractiveness, musical value, and unfamiliarity. They, as well as the analyses used in Method A, were approved by Professor Dykema and the staff of the Department of Music Education of Columbia University. Examination of the compositions (Appendix A), shows

them all to be tuneful, well constructed and of extreme, though not equal, simplicity, lying well within the first grade of piano difficulty. It is obviously impossible to find four compositions of exactly the same difficulty or which will seem of the same difficulty to all subjects in view of the varying equipments. The compositions are:

(1) Minuet by Johann Mann (Austrian, 1717–1750)
(22 measures. Playing time about 40 seconds)
(2) Jig by Henry Purcell (English, 1658–1695)
(16 measures. Playing time about 40 seconds)
(3) Toccata by Alessandro Scarlatti (Italian, 1659–1725)
(26 measures. Playing time about 45 seconds)
(4) La Lutine by Johann Kirnberger (German, 1721–1783)
(24 measures. Playing time about 54 seconds)

CHAPTER IV

THE EXPERIMENT

The experiment was conducted in the studio of the experimenter in New York City between June 22 and September 10, 1936.

Each subject appeared on four consecutive days for the learning, and on four consecutive days exactly three weeks later for the relearning. The learning for each subject was individual, no one else being present except the experimenter. Two hours were allowed for each learning and one hour for each relearning, but in most cases the full time was not needed.

For the learning by the A Method, the following routine was adhered to: The subject was seated comfortably at a table, and the musical score and its analysis given him. He was advised to go carefully over the musical score before studying it with the aid of the analysis. He was allowed twenty minutes for the entire study period. He then carried the musical score to the piano and was given these instructions: "You are going to practise this composition until you have memorized it and can play it through twice without errors and without stopping. Play as slowly as necessary to avoid errors and to maintain the rhythm exactly. Each time you will play the composition through from beginning to end without pausing to practise short sections. You may, however, correct errors. You may play at any rate of speed which you find comfortable. As soon as possible, do not look at the music and see how much of it has been memorized."

It will be observed that the only experimental limitation was the requirement to practise by "wholes" instead of "parts." This was done solely to standarize the procedure since there is no conclusive evidence that "whole" practising is superior to "part" practising.

Brown (5) comes to the conclusion that the efficiency of either is a function of the nature of the material itself. Eberly (10) found the "whole" method more economical. Sawdon (36) agrees with this conclusion. Reed (33) sums up the problem with the observations: (1) Different people memorize better by different methods. (2) By "wholes" oversteps the span of attention. (3) By "wholes" delays the perception of progress. (4) By "wholes" entails useless repetition of the known. These conclusions are quoted at length because all of them were confirmed during the learning in this experi-

ment. Observations by subjects indicated, also, that the first and last parts of the composition were most quickly learned and that a sense of annoyance resulted from the necessity to repeat all the known material in order to make one rereading of the less well-known. The relatively rapid learning of first and last parts of the score conforms with the results of Luedeke (25), Sullivan (23), and Bergeman (1), whose results, however, were derived from non-musical areas.

There was no attempt to regulate the speed of performance because the subject might be handicapped by going either slower or faster than he could comfortably manage. After a few repetitions, however, the compositions fell into what seemed to be a normal rate of speed for each. (Minuet at 100 M.M. = ♩, duration of one repetition about 40 seconds: Jig at 100 M.M. = ♩; duration of one repetition about 40 seconds; Toccata at 104 M.M. = ♪; duration of one repetition about 45 seconds; La Lutine at 108 M.M. = ♪; duration of one repetition about 54 seconds).

As far as possible no infractions of note or rhythm were allowed during the learning. The experimenter simply said, "careful," at any such infraction and the error was promptly corrected.

The experimenter, sitting near the subject, recorded time from the beginning of the first keyboard repetition to the end of the number of repetitions through the second successive accepted performance necessary for the learning, as well as places of principal errors. The standard for acceptance of a composition as learned was:

1. To play without score.
2. To play through without stopping.
3. To play no wrong notes.
4. To omit no notes.
5. To maintain the rhythm as written.
6. To play at the metronomic speed set for the composition.

When the subject had twice played the composition acceptably, he was admonished not to practise it and to think of it as little as possible. A high level of cooperation was apparent. He was then dismissed before the next subject appeared.

In Method B, the subject was again seated comfortably at a table and presented with the musical score as well as pencil and paper. He was given the following instructions: "Study the music carefully. Then write down any relationships concerning form, voice movement, chord lines, repetitions, and the like which you

find and which you think will be of use to you in memorizing the score. You may use abbreviations and symbols. These will not be corrected but are solely for your own use." Twenty-five minutes was allowed for the studying and writing. After this, he went to the piano as in Method A. The keyboard procedure was identical with the keyboard procedure in Method A.

In Method C, there was no preliminary study period. The subject went directly to the piano. He was warned to play the composition for the first time at a speed slow enough to avoid errors. Any infraction of note, rhythm or coordination of hands was checked immediately and corrected. This was also true for every repetition thereafter. The procedure from this point on was as described under A and B, time being clocked from the beginning of the first repetition.

Method D involved an additional step. The subject was seated before the phonograph and given the music score. He then listened to four successive repetitions of the composition while he followed the music score. The length of time required for four phonograph repetitions of the various compositions was approximately as follows:

1. Minuet, two minutes, 40 seconds.
2. Jig, two minutes, 40 seconds.
3. Toccata, three minutes.
4. La Lutine, three minutes, 36 seconds.

This listening period was not counted in the total learning time. After the listening, the learning proceeded by one of the three methods described above.

For the D Method, the twenty-four subjects were divided into three groups of eight persons each. One group of eight subjects learned a composition by the A Method after hearing four repetitions of the phonograph recording. The second group learned a composition by the B Method after hearing four recorded repetitions. The third group learned a composition by the C Method after hearing four recorded repetitions.

Three weeks after the initial learning the subjects returned to relearn the compositions in the same order as before but with no preliminary studying. The relearning, then, followed the C Method of the original learning, offering some advantage to the C method in that the relearning situation was similar to the learning situation. Before going to the keyboard an attempt was made to discover what recollections of the composition remained. Could the subject remem-

ber the key, the rhythm, the starting notes? Could he hum the melody? Often he remembered nothing until the experimenter hummed the beginning of the melody. Amount of recollection varied from complete blankness to an almost verbatim report of the given outline when it had been used in the original learning.

The relearning followed the procedure outlined under Method C. A record of time as well as the number of repetitions was kept from the beginning of the first repetition through the last two repetitions required to meet the learning standard of speed and accuracy.

CHAPTER V

PRESENTATION AND ANALYSIS OF DATA

Two basic statistical techniques have been employed to evaluate the relative efficiency of the four methods of memorizing piano music used in this experiment. The first is the test of the differences of the means of the methods for real or statistically significant differences. The second is the analysis of the total variance to discover the relative contribution to the total of each variable, especially the significance of method.

Analysis of Learning Time Variance

The use of variance analysis can best be explained by direct quotations from George W. Snedecor and from his book (39) "Calculation and Interpretation of Analysis of Variance and Co-Variance."

> Since its introduction by R. A. Fisher in 1923, analysis of variance has proved itself a useful addition to statistical methods. It is a technique for segregating from comparable groups of data the variation traceable to specified sources. In properly designed and successfully executed experiments it furnishes an estimate of experimental error freed of that part of the variability whose origin is known. In conjunction with a test of significance, it affords a basis of judgment as to whether or not several groups are samples from a single homogeneous population. Through the use of degrees of freedom it is equally well adapted to the treatment of larger or small samples. It lends itself readily to the design of efficient experimental procedures. . . . The word "variance" is used by Fisher to denote the square of the standard deviation. A more general term "mean square" will often be used here instead of "variance." The usual test of significance in analysis of variance is effected by the direct comparison of two mean squares. The term "experimental error" will usually be applied to that mean square which represents the residual variation isolated by analysis of variance and unexplained by experimental controls.
>
> The major portion of the calculations in analysis of variance is designed to furnish the sum of the squares of the deviations of a set of observed values from their mean. This quantity is designated by the abbreviated phrase "sum of squares." In a single set of values of the variable, X, the computational procedure is shown by the formula $\Sigma X^2 - \frac{(\Sigma X)^2}{N}$ where the second term is referred to as the "correction term," since it reduces the sum of squares of the observed values to the desired sum of squares of deviations from the mean.

It will be observed that in this experiment there are five variables, namely: (1) individuals, (2) groups, (3) compositions, (4) methods, (5) order. No attempt was made to equate either the individuals used as subjects, or the groups into which the subjects were divided.

Hence it would be expected that wide differences would exist among the individuals as well as within the groups. In a sense the differences *within* the groups are the same as the differences among the individuals, since the individuals comprise the groups. However, differences exist *between* the groups since the subjects were selected at random from the entire experimental group.

With regard to the several sources of variance, Snedecor says:

> If heterogeneity among the class means has been demonstrated, the theory is that each class may be a sample from a homogeneous, normally distributed population, and that if such populations all have the same variance the mean square *within classes* is a valid estimate of it. The total mean square results from variations both *within* and *between* the populations.

Since the groups conformed to the qualifications stated above, the mean squares of the group scores have been subtracted from the total variance, leaving the variance *within* individuals. Group variance is therefore eliminated and the number of variables is reduced to four.

The compositions used in the experiment were not strictly equated either for difficulty or length. Their differences would therefore account for some of the fluctuation around the mean learning time. Since methods and compositions were presented in ever-changing combinations to different groups of subjects, the order of the learnings accounts for some of the variance found in the whole. The four contrasting methods differ, of course, among themselves and would be expected to be accountable for a considerable share of the total variance. Though their variability in the learning time has been limited by equalizing the time allowed for each, the methods as the fourth variable will show slight contribution to the total variance of the learning time but very significant contribution to the relearning time and relearning repetitions.

The total variance has been analyzed to determine the percentage of the whole ascribable to each of these four variables and to the "experimental error," that part of the total not accounted for by the known variables.

Since each of the 24 subjects learned 4 compositions the total number of learnings, as well as the number of relearnings, was 96. Using the formula above, the 96 scores were squared and added. From this sum was subtracted the square of the sum of the scores divided by 96.

Concerning "Degrees of Freedom," Snedecor says:

The idea of degrees of freedom has proved to be puzzling to many people. While the origins of the concept lie in some rather elaborate mathematical theorems, certain rules and rationalizations have been proposed.

Of the 96 deviations from the mean only 95 are quite independent. This means that if the values of 95 deviations are chosen arbitrarily the 96th is fixed by the fact that the sum of the deviations must be zero.

The same idea is sometimes expressed by the statement that when from the set of N independent observed values the statistic $\bar{x}$ is calculated and used in computing the deviations, it is associated with one of the N degrees of freedom, leaving N–1 for the deviations, and, therefore for the sum of their squares.

Applying this concept to these data, there are 95 degrees of freedom for the total variance. Adding the 23, (24 – 1) for individuals; 3, (4 – 1) for method; 3, (4 – 1) for composition; 3, (4 – 1) for order, a total of 32 degrees results for the four variables. Subtracting this 32 from the total of 95 leaves 63 degrees of freedom for the residual or "experimental error."

A comparison of the variance of individuals, methods, compositions, and order, with the residual, results in a ratio of the greater to the lesser square. These ratios are compared with tabular values (21) given by Fisher for certain combinations of degrees of freedom. Fisher gives two tabular values: One designated significant, the other in bold face type designated highly significant. The former is expected to be exceeded in random sampling from a homogeneous population five times in a hundred trials, the latter only once.

The analysis of the variance of the learning time is shown in Table II.

TABLE II

ANALYSIS OF THE VARIANCE OF THE LEARNING TIME, SHOWING THE TOTAL VARIANCE, THE PERCENTAGE OF THE TOTAL ASCRIBABLE TO EACH VARIABLE, AND A COMPARISON OF THE RATIO OF THE VARIANCE OF THE VARIABLE AND THE EXPERIMENTAL ERROR WITH FISHER'S HIGHLY SIGNIFICANT TABULAR VALUE

	Sum of Squares	*Degrees of Freedom*	*Mean Square*	*Ratio of Greater to Lesser Mean Square*	*Fisher's 1% Value*	*Percent of Total Variance*
Total	78354	95	.....	.....	.....	.....
Individual	54978	23	2390.35	18.59	2.12	33%
Method	697	3	232.33	1.80	4.13	3%
Composition	12662	3	4220.67	32.8	4.13	55%
Order	1914	3	638.00	4.96	4.13	8%
Residual	8103	63	128.62	.....	.....	1%

Analysis of the learning time variance shows that method accounts for only 3 percent of the total. This is to be expected since two-thirds of the learning time scores were nearly equalized by adding twenty and twenty-five minute study periods preliminary to the keyboard learning. Since the intention was to equalize the learning time of the various methods, this low percentage indicates how nearly this was achieved.

Examination of Table I shows heterogeneity among the subjects. This is substantiated by the learning time variance analysis which shows a high proportion or 33 percent to be due to individual differences.

The compositions account for 55 percent of the variance of the learning time. Though of great simplicity, they varied considerably as to length and difficulty. (This is shown by the learning time means in minutes for each composition: Minuet 45.5; Toccata 55.9; Jig 62.3; La Lutine 76.8.)

The order in the methods of learning accounts for 8 percent of the total learning time variance. This may be due to the following factors:

1. The outline written by 12 subjects in Method B may have been beneficially influenced by previous study of the given outline in Method A.

2. Eighteen subjects learned by the C Method after previous learnings by either or both methods employing study periods.

3. Marked adaptation to the experimental situation was evidenced from day to day.

The residual or "experimental error" accounts for only one percent of the total variance; ninety-nine percent of the total variance being ascribable to the four variables.

Learning Repetitions

Of the total of 96 learnings, 64 included preliminary study periods. The number of repetitions required to learn the material after a study period of twenty or twenty-five minutes is obviously not comparable with the number of repetitions required at the keyboard when no preliminary study period has preceded. The learning repetitions have consequently not been treated statistically.

Differences of Means of Methods in Learning Time

In comparing the means of the methods, it will be remembered

that the learning time for all the methods was nearly equalized. This is borne out by Table III.[1]

TABLE III

MEANS AND STANDARD DEVIATIONS DERIVED FROM LEARNING TIME FOR METHODS A, B, AND C

	Mean	*S.D. of Distribution*
Method A	56.17	24.42
Method B	63.67	25.8
Method C	60.79	34.2

The average learning time for Methods A and B was increased by the addition of arbitrary study periods, twenty minutes for A and twenty-five minutes for B. The greatest variation was apparent in the group when Method C was used. The standard deviation of 34.2 is evidence of wide differences in learning time by the method which confined the total learning to the piano. Close as are the means of the methods, however, some advantage accrues to Method A.

The differences between the means of the learning time for the three methods are shown in Table IV.

TABLE IV

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS DERIVED FROM THE LEARNING TIME OF THE THREE EXPERIMENTAL METHODS A, B, AND C

Mean	*Difference*	*S.D. Difference of Mean*	$\frac{\text{Difference}}{\text{S.D. of Difference}}$
B–A	7.50	7.3	1.00
C–A	4.62	8.7	.53
B–C	2.88	8.9	.32

The differences in learning time between the methods are not statistically significant. This is to be expected since the learning time of Methods A and B could not be less than the study period of twenty and twenty-five minutes respectively, which was added to each of these scores and since the learning time of the methods was equalized. There was no such standard study period required in Method C but the total required time closely approached the time required by A and B.

[1] It will be noted that the data for Method D have been omitted. Method D is discussed on page 37.

Analysis of Variance of Relearning Time and Repetitions

The intention of this experiment was to evaluate the relative efficiency of four memorizing procedures, not by comparing the learning time required by each method, since this was equalized as nearly as possible; but by a comparison of the amount of time and the number of repetitions required to relearn, after a lapse of three weeks, material originally learned by the four different procedures. Since the relearning was done directly at the keyboard under conditions similar to Method C any advantage accruing to the various methods will be indicated here.

In Table V can be seen the marked contrast of the analysis of the variance of the relearning time with that of the learning time.

TABLE V

Analysis of the Variance of the Relearning Time, Showing the Total Variance, the Percentage of the Total Ascribable to Each Variable, and a Comparison of the Ratio of the Variance of the Variable and the Experimental Error with Fisher's Highly Significant Tabular Value

	Sum of Squares	*Degrees of Freedom*	*Mean Square*	*Ratio of Greater to Lesser Mean Square*	*Fisher's 1% Value*	*Percent of Total Variance*
Total	23151	95	.....	.....	.....	.....
Individual	11664	23	507.13	8.06	2.12	16%
Method	3544	3	1181.33	18.78	4.13	40%
Composition	3766	3	1255.33	19.95	4.13	41%
Order	213	3	71.00	1.13	4.13	2%
Residual	3964	63	62.92	.....	.....	1%

Methods here account for 40 percent of the total variance. The importance of the methods is even more clearly indicated in Table VI.

The analysis of the variance of relearning repetitions shows that to the various methods may be attributed 58 percent of the total variance which is 18 percent more than the contribution of the methods in the analysis of relearning time, indicating the great importance of the methods in relearning.

As methods become more important in the relearning time and relearning repetitions, individual differences drop from 33 percent in the learning time to 16 percent and 15 percent in the relearning time and relearning repetitions, respectively. There seems to be evidence, therefore, that individual endowment and individual learning

TABLE VI

ANALYSIS OF THE VARIANCE OF THE RELEARNING REPETITIONS, SHOWING THE TOTAL VARIANCE, THE PERCENTAGE OF THE TOTAL ASCRIBABLE TO EACH VARIABLE, AND A COMPARISON OF THE RATIO OF THE VARIANCE OF THE VARIABLE AND THE EXPERIMENTAL ERROR WITH FISHER'S HIGHLY SIGNIFICANT TABULAR VALUE

	Sum of Squares	*Degree of Freedom*	*Mean Square*	*Ratio of Greater to Lesser Mean Square*	*Fisher's 1% Value*	*Percent of Total Variance*
Total	6049	95	.....	.....	.....	.....
Individual	3023	23	131.45	9.72	2.12	15%
Method	1523	3	507.67	37.55	4.13	58%
Composition	556	3	185.33	13.71	4.13	22%
Order	95	3	31.67	2.34	4.13	3%
Residual	852	63	13.52	.....	.....	2%

approaches are less important factors than the method employed in the learning.

Compositions, though still showing large contribution to the total variance, become much less important than method, dropping from 55 percent in the learning time to 41 percent in the relearning time and to 22 percent in the relearning repetitions. The 41 percent may be due to the fact that the compositions were unequal in length and accounted for greater variation in the relearning time than in the relearning repetitions. The drop of 22 percent in the relearning repetitions offers evidence that the varying difficulty did not require a proportional variation in the number of repetitions necessary for the relearning.

Order drops to 2 percent of the relearning time variance and to 3 percent of the relearning repetitions variance and is both times well below Fisher's tabular value.

The residual variance or the "experimental error" is in every case negligible, ranging from one percent to two percent of the whole. There is little doubt therefore that practically the total variance has been accounted for by the four variables involved in the experiment.

DIFFERENCES IN MEANS OF METHODS IN RELEARNING TIME AND RELEARNING REPETITIONS

The means and standard deviations of the relearning time and relearning repetitions for Methods A, B, and C are contained in Table VII.[2]

[2] The data for Method D will be found on page 37.

TABLE VII

MEANS AND STANDARD DEVIATIONS DERIVED FROM RELEARNING TIME AND RELEARNING REPETITIONS FOR METHODS A, B, AND C

	Method A		*Method B*		*Method C*	
	Mean	*S.D. of Distribution*	*Mean*	*S.D. of Distribution*	*Mean*	*S.D. of Distribution*
Relearning Time	12.04	9.96	16.08	13.8	28.46	15.42
Relearning Repetitions	7.76	4.00	9.92	6.8	18.37	8.00

The shortest average relearning time (12.04) is found in Method A, in which the subject studied the score with the aid of a prepared outline.

Method B ranks second (16.08). In this method it will be recalled, the student prepared an outline while studying the score.

The average relearning time by Method C (28.46) is more than twice the average relearning time for Method A and almost as great for Method B.

By relearning repetitions is meant the number of times it was necessary for the subject to play the composition before reaching an acceptable standard of performance.

The fewest repetitions for the relearning (7.76) were required for Method A. In second place is Method B with (9.92). In contrast to this, Method C required an average of (18.37), more than twice the number needed for Method A. The means of the methods show wide differences. Table VIII shows the significance of the differences of the means of the relearning time.

TABLE VIII

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS DERIVED FROM THE RELEARNING TIME OF THE THREE EXPERIMENTAL METHODS, A, B, AND C

Mean	*Difference*	*S.D. Difference of Mean*	$\frac{\textit{Difference}}{\textit{S.D. Difference}}$
B–A	4.04	3.6	1.10
C–A	16.42	3.8	4.30
C–B	12.38	4.3	2.90

The two methods, A and B, which required analysis, differ but little. So small is this difference, indeed, that it may be inferred

that with more subjects, or with additional experimentation, the averages in relearning time by Method A and Method B will be indistinguishable. The evidence of the obtained difference between Methods A and B allows the conclusion that the subject's own outline proves almost as useful in the learning as the use of one provided by the experimenter.

Methods A and C and Methods B and C, however, show very large differences in favor of A and B. The ratio of 4.3 derived from the differences of A and C is well over the ratio 3 which is commonly accepted as indicating genuine statistical differences.

From the data, it may be inferred that in similar groups of subjects, the differences would be greater than zero. The ratio 2.9 derived from the differences of Methods B and C will support the same inference. Analysis supplied either by some competent musical authority or an analysis developed by the student musician definitely aids the memorization of piano music such as was used in this experiment.

The evidence seems definitely to be conclusive, therefore, that methods A and B, using analytical study before keyboard learning, are markedly more efficient than Method C, which confines the learning to the keyboard.

Table IX shows the differences between the means for relearning repetitions in the various methods.

TABLE IX

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS DERIVED FROM THE RELEARNING REPETITIONS OF THE THREE EXPERIMENTAL METHODS, A, B, C

Mean	*Difference*	*S.D. Difference of Mean*	$\frac{\textit{Difference}}{\textit{S.D. Difference}}$
B–A	2.16	1.6	1.3
C–A	10.61	1.9	5.6
C–B	8.45	2.2	3.8

No statistical significance is indicated in the ratio 1.3 for Methods A and B. The difference between Methods A and C is large, the ratio 5.6 being well over 3 sigmas. The difference between Methods B and C is statistically reliable.

The differences in the relearning repetitions present a clearer picture than the differences in the relearning time. Since speed of playing was not regulated, the most economical learning is indicated

by the lowest number of repetitions required to reach the standard learning.

There is indisputable evidence here that the differences between Methods A and C and between Methods B and C are real and would be maintained in the same direction in another population sample.

Method D

Method D was designed to test the efficacy of hearing the musical material a sufficient number of times to produce a firm auditory image before the formal learning was undertaken.

Since only eight subjects added preliminary hearing to any one method, and since only one composition was learned by each method, the average of each eight can obviously not be compared with the average of 24 learnings by any one method and including all four compositions.

Therefore, the average of the 24 learnings by the D method is compared with the average of the 72 learnings by the other three methods together. These results appear in Table X.

TABLE X

Comparison of the Means and Sigmas, Derived from Learning Time, Relearning Time, and Relearning Repetitions for Method D and Methods A, B, and C Combined

	Learning Time		*Relearning Time*		*Relearning Repetitions*	
	Mean	*S.D. of Distribution*	*Mean*	*S.D. of Distribution*	*Mean*	*S.D. of Distribution*
Method D	59.5	26.4	20.21	15.48	12.75	7.92
Methods A, B, C Combined	60.2	28.6	18.86	14.96	12.01	7.90

In the learning time the slight difference in favor of the D Method is negligible. In the relearning time and relearning repetitions the difference is greater but in the reverse direction.

Since it seems unreasonable to suppose that familiarity with the sound of the musical score can prove a hindrance to the learning,[3] it may be assumed that the experimental procedure was inadequate to show existing differences or that unknown factors were operating to obscure the true picture.

[3] Raif (31) found that a composition can be played more readily after it has been heard than before. This conclusion does not, of course, extend to include the relative speed of memorizing, though if the learning is facilitated, it might be expected that the learning-memorizing time would be reduced.

Diagram of Differences in the Means of the Methods

Diagram I presents graphically the relative efficiency of Methods A, B, and C as represented by the distance of the mean of each method from their average mean.

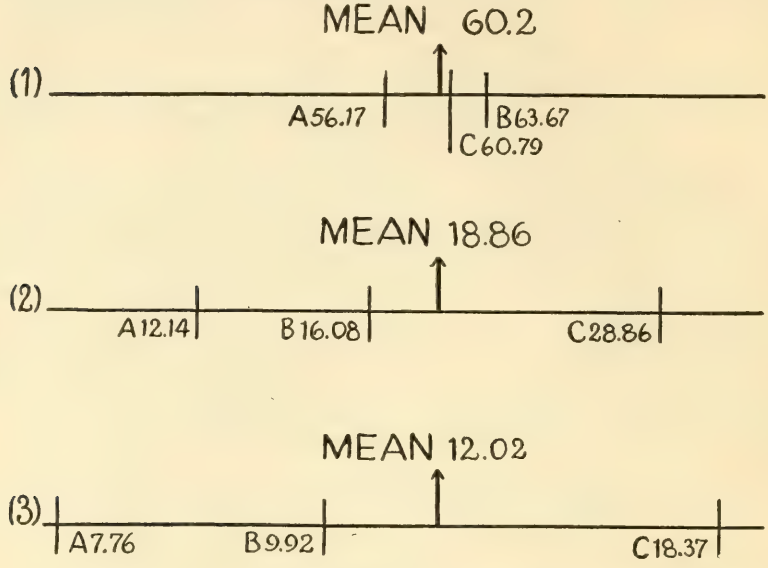


Diagram I

Diagram of (1) Learning Time, (2) Relearning Time, (3) Relearning Repetitions; showing the Fluctuations of the Means of Methods A, B, and C around their Average Mean.

Here the means of the methods of the learning time vary only slightly around the average of the three means of Methods A, B, and C. In the relearning time, the variation is large, showing Methods A and C farthest apart on either side of the mean. In the relearning repetitions the variations are even more striking, showing the large superiority of Method A over Method C as both diverge from the mean.

CHAPTER VI

CORRELATIONS

The scores of the tests described in Chapter III were correlated with age, learning speed and relearning speed, piano and theoretical experience.

If, as is customary, it is expected that a relationship exists between mental ability and learning time, then for these data the correlation will be negative, since the less able the learner, the greater the time taken for learning.

The correlations between the scores found for learning, relearning, age, verbal memory and Otis appear in Table XI.

TABLE XI

CORRELATION OF LEARNING AND RELEARNING WITH AGE AND INTELLIGENCE

	Verbal Memory	*Otis*	*Learning*	*Relearning*
Age	−.54	−.46	.41	.43
Verbal Memory		.51	−.47	−.56
Otis			−.63	−.67
Learning				.94

The high correlation of .94 between learning and relearning is supported by Peterson (30) who found correlations of .87 and .94 between learning and retention of sense material. Stumpf's (40) correlation of .71 for the relearning of logical material is close.

The fairly high negative correlations of Otis and learning and Otis and relearning of −.63 and −.67 (increased Otis score with decreased learning time) are corroborated by Garrett's (14) study of learning and intelligence. Garrett (14), however, found a higher relationship between intelligence and learning than between intelligence and retention.

The correlation of .51 between Otis and verbal memory is duplicated by Garrett (14) who found a relationship of .52 between intelligence and five memory tests, though this figure was lower with individual memory tests. The correlation of −.46 of Otis and age is verified by Lorge's (23) results indicating that age has a definite effect on the score of such intelligence tests as Otis even when the intelligence level is the same. The degree of dependence, .41, between age and learning (*i.e.*, the greater the age, the longer the learning time required) is supported by Thorndike's (42) work with adults.

It is possible, however, that slower learning might have been due not to age but to poorer learning ability. The slightly larger correlation .43 between age and relearning time is upheld by Worcester (46) who found that increase in age over twenty affects retention more than learning.

Table XII shows the correlations between music tests and music training.

TABLE XII

CORRELATION OF MUSICAL TRAINING AND MUSIC TESTS

	K–D	*Theoretical*	*Piano Experience*
Seashore	.70	.55	.04
K–D		.16	.06
Theoretical			.36

The two Seashore tests show a high correlation, .70, with the Kwalwasser-Dykema tests. Only the tonal memory tests are similar.

The correlation of .04 between piano experience and Seashore indicates independence. Since the Seashore tests measure sensory capacity, this result might be expected.

It is interesting to observe that the correlation .06 between the Kwalwasser-Dykema music tests and piano experience also approaches zero although four of these tests presuppose musical experience.

Another contradiction is seen in the low correlation .16 between the Kwalwasser-Dykema music tests and theoretical training and the higher .55 between theoretical training and Seashore.

Table XIII shows the correlations of age, learning, relearning, verbal memory, memory, Otis, piano and theoretical experience and the music tests.

TABLE XIII

CORRELATION OF MUSIC TEST SCORES AND MUSICAL EXPERIENCE WITH LEARNING AND INTELLIGENCE SCORES

	Seashore	*Kwalwasser-Dykema*	*Theoretical Training*	*Piano Experience*
Age	−.31	−.21	.12	.....
Learning	−.71	−.66	−.52	−.18
Relearning	−.74	−.69	−.56	−.22
Verbal Memory	.51	.56	.05	−.06
Otis	.68	.72	.41	−.06

The correlations of piano experience with other factors in Table XIII are either negligible or extremely low. The number of years at the keyboard does not seem to influence speed or ability in learning. Haphazard memorizing over many years seems to add nothing to memorizing efficiency or relearning speed.

The high correlation of Otis and the Seashore tests of .68 does not support previous work. Fracker and Howard (11) find low correlations between these two tests and intelligence. Their results are supported by Mainwaring (27).

These are also the findings of Seashore and Mount (37) who maintain that general intelligence favors the securing of a good record, but that this is quite different from holding that general intelligence positively correlates with psycho-physical capacity.

The high correlation between learning time and Seashore scores found in this study may be explained by the limits of the group and the possible limits of the music tests themselves. Mursell (29) supports this by the explanation that the tests may correlate high with achievement when the group is extremely heterogeneous and because the tests discriminate roughly but not finely.

A higher correlation between the Otis test and the Kwalwasser-Dykema tests would be expected, since discrimination is involved in the tests of Pitch Imagery and Rhythm Imagery.

Though a correlation of .52 exists between theoretical training and learning, analysis of the subjects will show that this may be misleading. This rather high degree of dependence may be due to the fact that the more intelligent and more musically able were encouraged to go on with the theoretical work.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Despite the hundreds of research studies which have appeared as a result of the universal concern with the fundamentals of the psychology of learning, the area of music learning has been almost neglected. Few psychologists are musicians, and few musicians are psychologists, though the more alert among them have industriously attempted to incorporate "practical" psychological maxims into their working and teaching procedures. How confused and conflicting their theories are can be seen from even a cursory examination of their published observations.

The introduction of the Seashore Tests of Sensory capacity in 1919 marked the beginning of an interest in music tests of all kinds to measure native talent, musical information, and to predict possible achievement. Aside from tests such as these, however, little has been done to explore the intricacies of optimum procedures in acquiring musical skills or retaining them.

The subject of musical memory has always been of profound concern to music teachers and music students alike and lack of success in memorizing has proved baffling and discouraging. The psychological aspects of memorizing piano music are many. Such memory is at once a complex motor skill, a visual process involving printed note and keyboard images, an auditory process including sound images both felt and heard and a cognitive and intellectual process which analyzes and resynthesizes the musical structure and the inherent relationships.

With the exception of Kovacs' (22) study, the writer can find no evidence of attempts to deal with this problem. That the problem remains a perplexing one and urgently in need of solution is clearly apparent in discussion with students of piano and from the vague gropings of teachers of piano in search of a workable method.

The present study was undertaken to explore only one aspect of the problem. An attempt was made to discover whether extra stress on the cognitive and intellectual factors in the memorizing would prove of greater efficiency than allowing this factor to be haphazard and incidental, as it seems to be with most students.

Four methods of memorizing piano music were compared for their relative efficiency. The methods were selected to compare the value of deriving logical concepts concerning the structure and

details of piano music before keyboard learning with a method which consisted only of keyboard learning. Two of the methods involved the use of study and analysis before learning. In one the studying was done with the aid of a prepared analysis, in the other the analysis was prepared by the subject. The third method included no study previous to the keyboard learning. The fourth method was designed to test the value of familiarity with the musical material from hearing it before learning it by any of the other methods. Since the purpose of the experiment was to allow equal allotments of time to learning of the musical compositions by any of the four methods, the efficiency of the methods cannot be measured by the learning time. The time required to relearn material previously learned by any method, however, offers a striking picture of the relative superiority of one method over the other. Both methods employing analytical study periods before keyboard practise showed marked superiority over the method in which the analytical study period is omitted. These differences, furthermore, are so large that it may be inferred that the superiority of analytic methods over haphazard keyboard practise applies not only to the group tested but to other groups of piano students.

As a matter of observation, the students evidenced annoyance and irritation under the method of learning without preliminary study. Whereas it was also observed that after studying the analysis, the keyboard rendition seemed to be firmer and less subject to error than when the composition was practised immediately at the keyboard. The suggestion of Thorndike (43) and Lorge (24) against allowing error in initiating learning seems to be pertinent to the analytic methods. Since the analytic methods allow fewer errors there is obviously a smaller probability for error to persist.

Since all the experimental compositions were of first grade difficulty, it might have been assumed that experienced pianists would not need to make analyses of the compositions preliminary to playing, but would have been able to appreciate the details of form and structure while engaged in playing. This is not so. The data showed definitely that analysis proves markedly superior in the learning of even such simple material. It may be inferred that this procedure would prove of great aid in increasing the efficiency of memorizing more difficult music. It is not asserted that the methods found superior here are the best of all possible methods, but rather that they are undoubtedly superior to the immediate keyboard practise commonly used by piano students.

Preliminary hearing of the musical material before learning shows no advantage in relearning over doing without this preliminary hearing. It may be that the experimental procedure was inadequate or that unknown factors were operating to obscure the true relation. The role of auditory imagery as a basic aid in music learning needs further investigation.

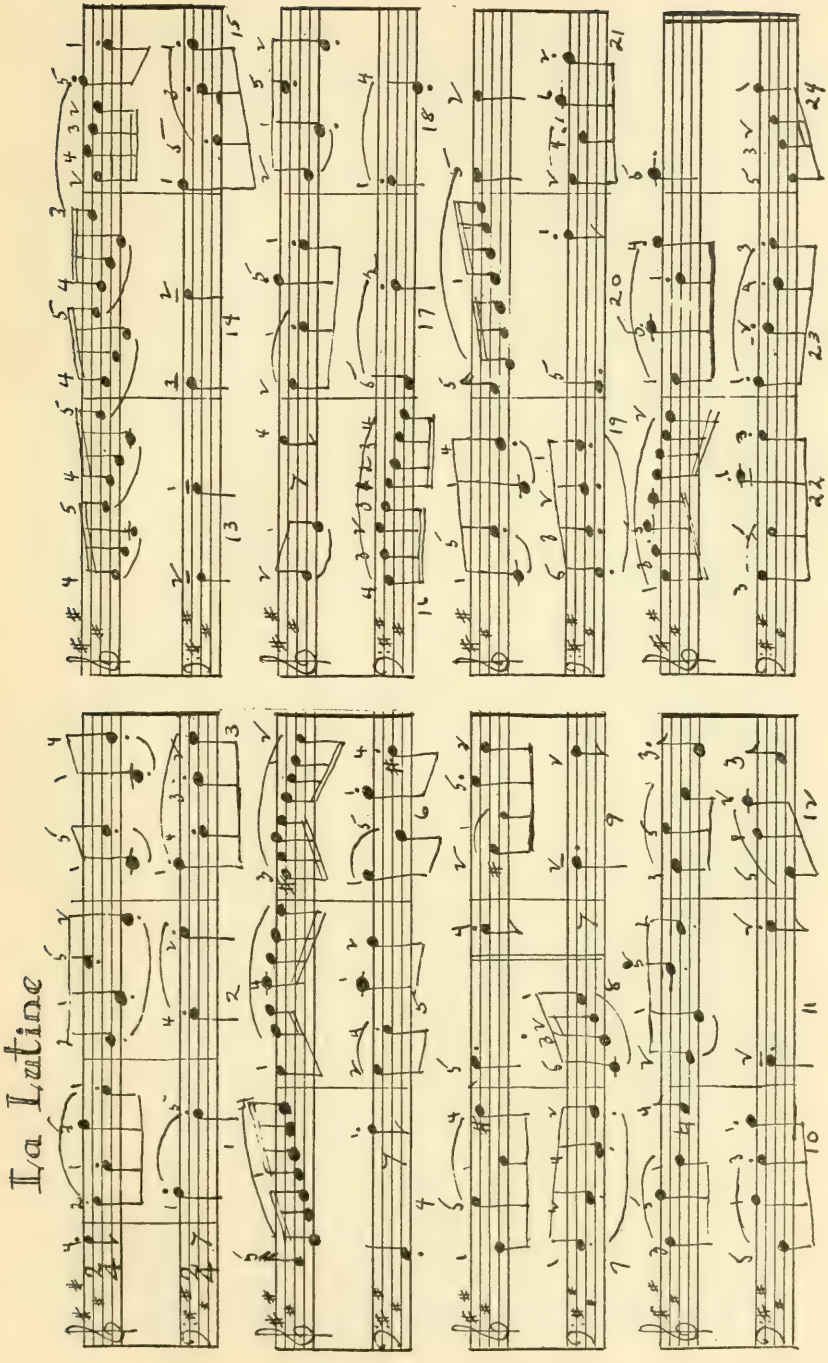
The requirements of the learning situation were such that the subject was obliged to begin memorizing almost coincident with the learning. Such intensive learning-memorizing is foreign to most piano students to whom learning merely to play a composition and memorizing it are separate functions, the latter being added when the former has already been accomplished.

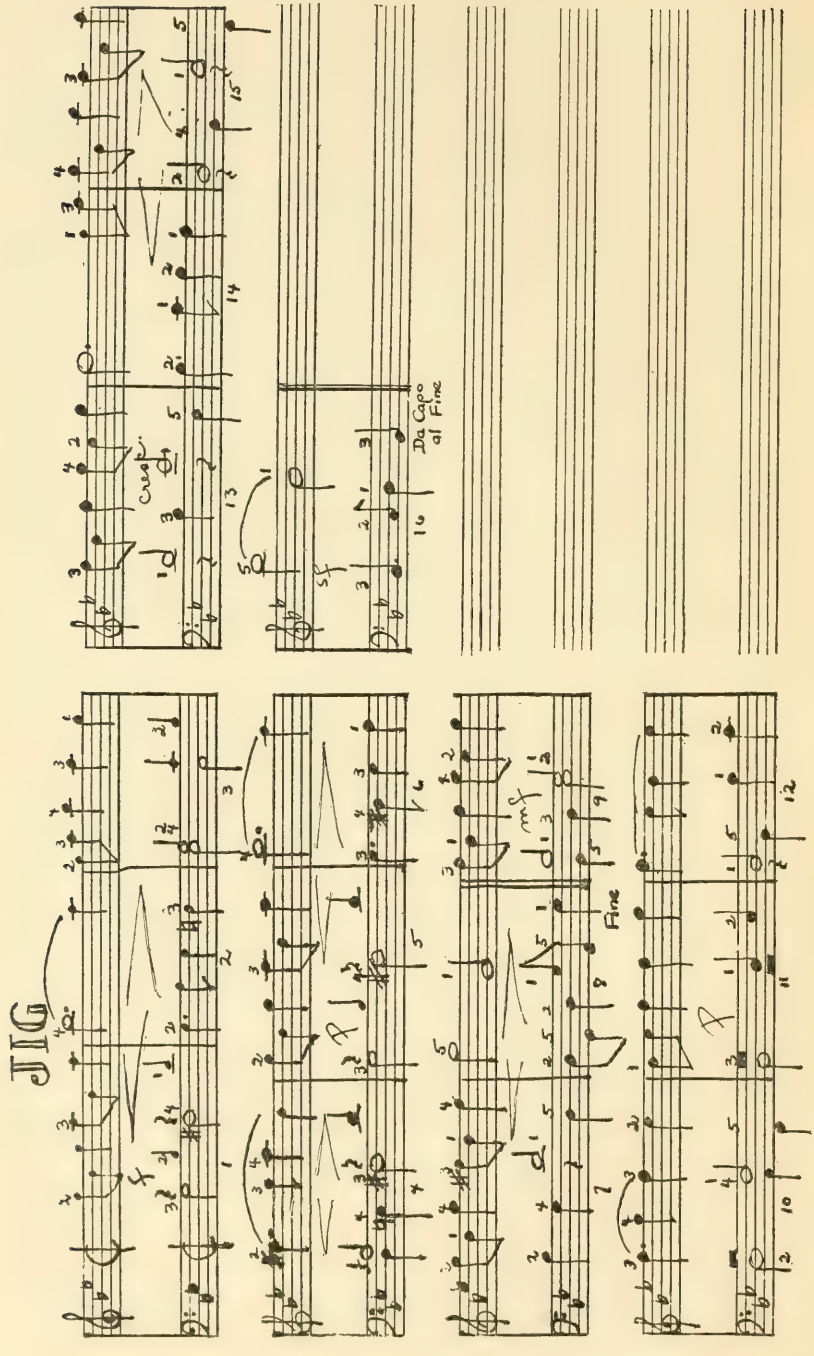
Though none of the experimental subjects had previously either silently studied a piano composition or written an analysis of it previous to playing it at the keyboard, the method which included the formulation of an analysis by the subject proved superior to the method without such analysis. Even inexpert and inexperienced analysis, therefore, is very much better than none at all. Since many of these analyses were written after the use of the experimenter's analysis, some of them were probably influenced favorably by the model. It is, however, quite possible that more was observed than was written and that what was written was more clearly observed than formulated.

The experimental group was extremely heterogeneous, being slightly above average in intelligence and somewhat superior as measured by the various music tests given, though this latter must be interpreted in the light of the fact that no subject had less than four years of piano experience or less than one term of theoretical experience. Though individual differences were large, they proved to be much less important in the relearning than the methods and it may be assumed that for most students, the analytical study of the music will prove superior to the immediate keyboard practise.

Since practically no relationship exists between piano experience and learning, experience in playing does not imply that memorizing of new material will be quickened in direct ratio to the amount of such experience.

APPENDIX A

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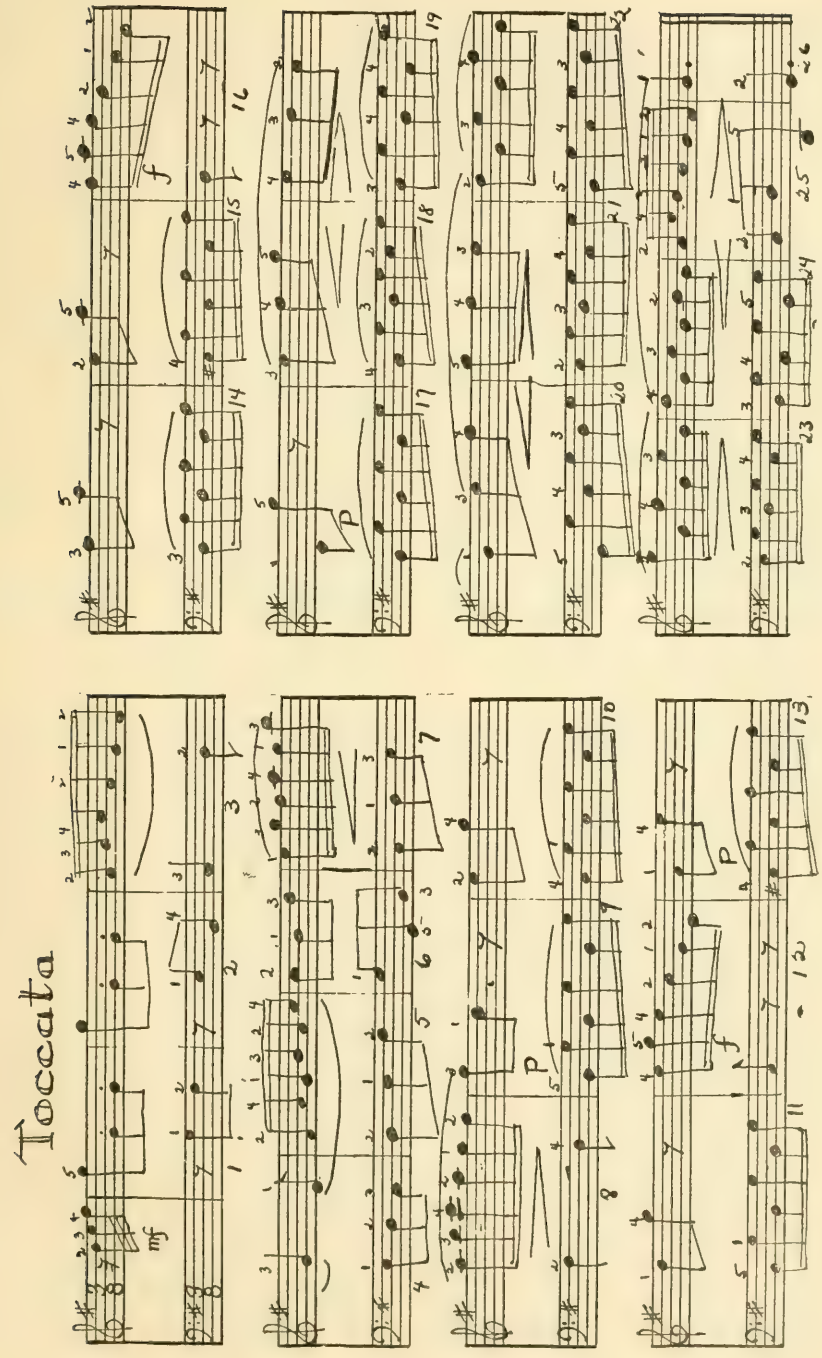
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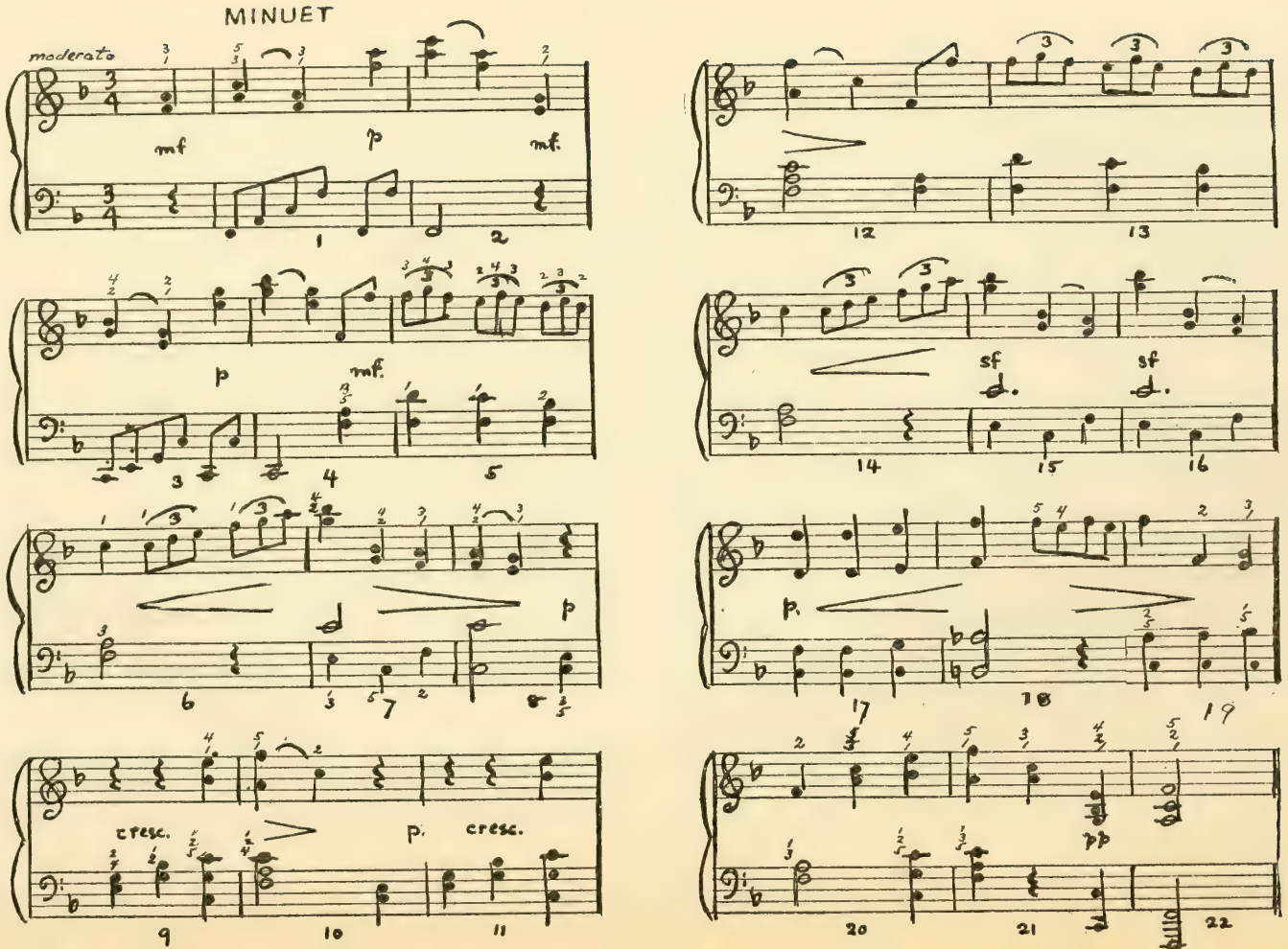
MINUET
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cresc.
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22

APPENDIX B

Three of the analytical outlines prepared by the experimenter appear below. The fourth, the analysis of the Minuet, appears in the text on page 15.

JIG

1. This composition is divided into three sections: the first M 1–8, the second M 9–16, the third, which is a repetition of the first M 17–24. (During the experiment this third section was not played. Since it was a duplicate of the first, it would otherwise have been repeated twice as often as the second section. There was, however, no feeling of incompleteness since each repetition began again with the first section.)

2. Two rhythmic figures predominate.

   a. The first of two eighths and a quarter note, as in measure 1 and M 5.

   b. The second of a dotted quarter, an eighth and two quarter notes as in M 4.

3. The first section is in G Minor, in which we have the raised 7th, F sharp. The second section is in the related key of B flat Major in which the F sharp becomes F natural.

4. M 1–4 and M 5–8 are very similar in melodic construction but show these differences:

   a. In M 3, the R.H. moves up from the G, while in M 7 the G moves down to D.

   b. The second rhythmic figure in M 2, the L.H. moves up from the G, and then moves down stepwise to the E flat in M 3, while in M 6, the L.H. moves first downward and then ascends stepwise to the B flat in M 7.

5. M 7 and 8 finish the section on the chords G–B flat—, D–F sharp—(A), and G— (B flat)—D.

6. M 9–12 and M 13–16 have some melodic similarities, but the melody in M 10, R.H. moves downward, while in M 14 moves upward.

7. The L.H. and R.H. in M 11, 12, 13 run parallel at the interval of a third. (This applies to the upper voice in the L.H.)

8. M 15 is built first on the B flat—D—(F) chord, then on the chord F–A–C.

9. M 16 ends the section with an octave drop on B flat, R.H. as M 8 ended the first section with an octave drop on G.

TOCCATA

1. This composition is divided roughly into two sections, M 1–16, M 17–26.

2. The two important rhythmic figures are 3 eighth notes as in M 1, and 6 running sixteenths as in M 3.

3. The L.H. for the most part forms an accompaniment to the R.H. at the intervals of a third and a sixth.

4. M 2 repeats the figure in M 1 while the L.H. moves stepwise through M 5 to the G in M 6.

a. From the B in M 6, it continues stepwise to the F sharp in M 8.

5. The R.H. in M 5 moves up stepwise in thirds while the L.H. follows it at the interval of a third.

a. The figure in M 7, R.H. is similar to it in construction, followed by M 8, whose R.H. is a repetition of the R.H. in M 3, but one octave higher.

6. M 9–12 forms a pattern similar in construction to M 13–16. The latter is, in general, one step higher than the former in both hands.

a. In both patterns the L.H. in sixteenths moves parallel with the R.H. in eighths.

b. In M 9–12, the L.H. keeps the G constant. In M 13–16, the L.H. keeps the A constant.

c. M 12 which ends the first pattern is the 16th note figure running down on the C–E–G chord, as M 16 which ends the second pattern is the 16th note figure running down on the D–F sharp A chord.

7. In M 17–24, the L.H. figure keeps the G constant and moves parallel with the melodic line in the R.H.

8. M 22–24, the R.H. imitates the L.H. figure, running with it at a distance of a third and keeping the G constant.

9. M 25 has the chord line D–F sharp–A–C.

LA LUTINE

1. This composition is divided into three sections of eight measures each. The end of the first section is marked by a change of key and the D sharp in M 6 establishes the new key of E Major, affirmed in M 8 by the E–G sharp B chord over an octave stretch.

2. Throughout the piece, the L.H. stays, for the most part, at the interval of a third and sixth with the R.H.

3. M 1 and 2 are similar, though not alike, in melodic construction.

4. M 3 has a melody formed by 2 consecutive sixths, C sharp—A, and B–G sharp.

5. M 4 is the scale of A Major, running from E to the E in M 5.

6. M 7, like M 3, forms its melody by using two sixths.

7. The second section, beginning with M 8, is introduced by the C sharp of the previous M. This C sharp introduces a melodic figure which ends with R.H. in M 10.

a. If considered as chords, this figure is made up of F sharp–A sharp–C sharp–E in M 9, and of B–D–F sharp in M 10.

b. Similarly, the A natural in M 10 introduces a figure ending on the A of M 12 which is very like the previous figure in its construction, but is built one note lower.

c. If considered as chords, the figure is built on the chord E–G sharp–B–D in M 11 and on A–C sharp–E in M 12.

d. The L.H. of both figures also has similarities of construction. The F sharp of M 9 descends to the E of M 11, moving down one tone as does the R.H. Also the drop of a fifth from M 9 to M 10 is repeated from M 11 to M 12.

8. The last note of M 12 introduces a figure in sixteenths which is indicated by the slurs above each.

a. In each case there is an interval of a 7th between the last note of one and the first note of the next.

b. Each figure can be reduced to a chord: M 13, B–D–F sharp; C sharp–E–G sharp. M 14, D–F sharp–A; E–G sharp–B.

c. This whole pattern may also be seen as follows: Each note at the beginning of each little sixteenth note figure forms a step in a stepwise progression, namely in M 13, A and B; in M 14, C sharp and D; continuing with E and F sharp in M 15; which runs at the distance of a fifth with the L.H. namely D–E–F sharp, G sharp A.

d. Both the L.H. and the R.H. in M 13 and 14, move up stepwise and remain parallel at the interval of a third.

9. The last note in M 16 introduces the third section, which through M 20 is a repetition of M 1–4, though some of the L.H. notes drop an octave.

10. M 22 is built on the E–G sharp–B chord, plus a scale in A running into the C sharp in M 23.

11. M 23 is very like M 3, except that it is one octave higher in the R.H.

a. The second L.H. note has changed from C sharp to F sharp.

12. M 24 is built on the A–C sharp–E chord in an octave stretch.

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